Purpose: When Tony Hawk wants to launch himself as high as possible off the half-pipe, how does he achieve this? The skate park is an excellent example of the conservation of energy. The law of conservation of energy tells us that we can never create or destroy energy, but we can change its form.

In this lab, you will analyze energy transfer between gravitational potential energy, kinetic energy, and energy lost due to collisions or friction (thermal energy) as a skate boarder rides along a track.

Instructions: Go to the web address written below, and click the “Run Now” button (Run Now). The simulation will open in a moment.

http://phet.colorado.edu/en/simulation/energy-skate-park-basics

Take some time to play with the simulation. Turn on the ‘Bar Graph,’ ‘Grid,’ and ‘Speed’ options on the right side of the screen. Become familiar with the ‘Reset’ buttons on the right and how to change the speed of the simulation with the buttons on the bottom.

Part I: Introduction  
(Turn on the ‘Bar Graph,’ ‘Grid,’ and ‘Speed’ options.)
Set the skater 2 meters above the ground on the ramp and release him.

1. What type of energy does the skater have at the 2 meter mark?

   The skater has mechanical/gravitational potential energy at the two meter mark.
2. How high does the skater get on the other end of the ramp?

*The skater gets to two meters high on the other end of the ramp.*

3. Explain, in terms of the conservation of energy, why the skater will never go higher than your answer to question 2 at this point.

*In terms of the conservation of energy, the skater will never go higher than two meter on the other end of the the ramp because energy can be neither created nor destroyed.*

*Hit the ‘Reset All’ button.*

4. If you were to place the skater at the 5 meter mark, how high will the skater go on the other side of the track? Try it to confirm your prediction.

*If the skater is placed at the five meter mark on the ramp, he will travel only five meters high on the other side of the track.*

5. How does the skater’s *kinetic* energy change as he moves down the ramp?

*The skater’s kinetic energy increases as he moves down the ramp.*

6. How does the skater’s *kinetic* energy change as he moves up the ramp?

*The skater’s kinetic energy decreases as he moves up the ramp.*

7. How does the skater’s *potential* energy change as he moves down the ramp?

*As the skater moves down the ramp, his potential energy decreases.*

8. How does the skater’s *potential* energy change as he moves up the ramp?

*The skater’s potential energy increases as he moves up the ramp.*

9. How does the skater’s *total* energy change as he moves down the ramp?

*The skater’s total energy does not change (it remains the same as it was in the beginning) as he moves down the ramp.*

10. How does the skater’s *total* energy change as he moves up the ramp?

*The skater’s total energy does not change (it remains the same as it was in the beginning) as he moves up the ramp.*
11. Describe the skater’s *kinetic* energy at the bottom of the ramp.

   The skater’s kinetic energy is at its highest at the bottom of the ramp, as none of it has been used. Potential energy was being used to get the skater to the bottom of the ramp.

12. Describe the skater’s *potential* energy at the bottom of the ramp.

   The skater’s potential energy has been depleted at the bottom of the ramp, and is converted to kinetic energy.

13. What happens when the skater is dropped onto the ramp from above? (Hint: look at the bar graph.)

   When the skater is dropped onto the ramp from above, the potential energy decreases and the kinetic energy increases. Every time the skater bounces from the impact, thermal energy is gained, and both potential and kinetic energy are lost.

   What happens to the total energy when the skater is dropped onto the ramp from above? (Again, look at the bar graph.)

   When the skater is dropped onto the ramp from above, the total energy remains the same from beginning to end.
14. Observe the following situations. Draw the possible bar graphs for the situation shown. Compare your results with a nearby lab group, AFTER you have completed this section.

- Top of the ramp, stopped for just an instance.
- Bottom of the ramp, zooming past the middle.
- Mid-way down the ramp, moving about mid-speed.
- 3/4 of the way down the ramp, moving pretty fast.

15. Draw where the skater might be based on the bar graphs shown. Compare your results with a nearby lab group, AFTER you have completed this section.
16. Consider this zany track. What point or points on this track would the skater have ...

The most kinetic energy?  C

The most potential energy?  A

The same kinetic energy (two points) B and E

**Part II: Track Playground**

Click the ‘Track Playground’ tab at the top. Using the track pieces in the upper right of the page, build a track with a single loop, like the track shown in the picture below. Be sure the far left and far right of the track are higher than the loop.
Turn on the ‘Bar Graph,’ ‘Grid,’ and options. For now, set the ‘Friction’ option to ‘Off,’ and the ‘Stick to Track’ option ‘On.’

Using the grid, what is the height of the top of the loop: 4.8 meters

Try placing your skater at different starting points on one side of the track.

17. What is the minimum height you can place the skater so that he makes it all the way around the loop?

The minimum height you can place the skater so that he makes it all the way around the loop is 5 meters.

18. Explain, in terms of energy, why the skater must be at the height in question 17 to make it through the loop.

Because the height of the top of the loop is at 4.8 meters, and the Law of Conservation of Energy states that energy can be neither creates nor destroyed, the skater must be placed at the height of 4.8 meters, which will take him to the peak of the loop. Kinetic energy will help the skater make it down the rest of the loop.

19. With the friction off, does the kinetic energy ever get as high as the total energy? If so, when? If not, why?

With the friction off, the kinetic energy doesn’t get as high as the total energy because there is still some potential energy in use to be taken into account.

Set the ‘Friction’ option to ‘On.’

20. With the friction on, does the kinetic energy ever get as high as the total energy? If so, when? If not, why?

With the friction on, the kinetic energy doesn’t get as high as the total energy because the friction causes heat, and some thermal energy is produced. So, kinetic, potential, and thermal energy must be combined to add up to the total energy.

21. Now with the friction on, what is the minimum height you can place the skater so that he makes it all the way around the loop? Is this different than if friction were turned off?

With the friction on, the minimum height I can place the skater so that he makes it all the way around the loop is 6 meters. This is about a meter higher than if the friction were turned off.

22. In one of the previous questions, we say you may have “lost,” or “dissipated” some energy. Where is this energy going according to your bar graph? What does this mean in real life?

The “lost” energy is going towards thermal energy. This means in real life that heat is being created due to the friction.
23. Energy can be dissipated (or “lost”) in another way on this simulation. What is one more way that you can find that you will “lose” energy?
One way that energy can be dissipated is when it is turned into heat. Another way it can be dissipated is when sound is emitted from the wheels rolling on the ground.

Create a track of your own. Draw in in the diagram below. Label where on the diagram you have the greatest kinetic energy, the greatest potential energy, and two places that have the same potential energy.